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Nakamizo et al.

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(54) **TIRE**

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See application file for complete search history.

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(*) Notice: Subject to any disclaimer, the term of this
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U.S.C. 154(b) by 1077 days.

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(30) **Foreign Application Priority Data**

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(57) **ABSTRACT**

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B60C 11/03 (2006.01)

B60C 11/12 (2006.01)

(52) **U.S. Cl.**

CPC **B60C 11/11** (2013.01); **B60C 2011/1213**
(2013.04); **B60C 11/12** (2013.01);

(Continued)

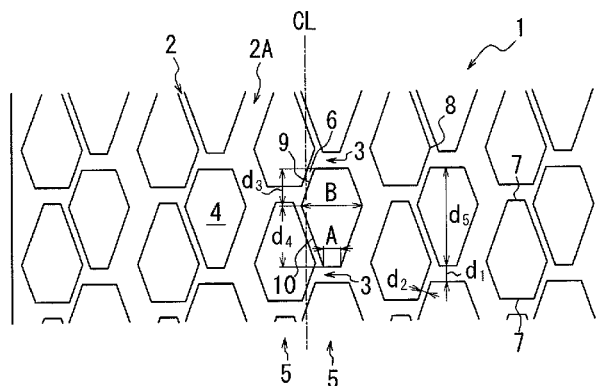
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CPC B60C 11/0306; B60C 11/0309; B60C 11/11;
B60C 11/12; B60C 2011/0346; B60C
2011/0348; B60C 2011/0353; B60C
2011/0365; B60C 2011/1209; B60C
2011/1213

USPC 152/209.27, 209.28, 209.25, DIG. 3,
152/902, 209.18

Provided is a tire exhibiting both improved partial wear resistance and improved quietness. The tire has block land portion arrays **5** defined on a tread portion **1**. Between adjacent two block land portion arrays **5** sandwiching a circumferential groove **2**, block land portions **4** constituting the block land portions **5** are arranged so as to be positionally displaced from each other in the tire circumferential direction, and a groove portion **6** between the block land portions adjacent in the tire width direction extends obliquely with respect to the tire width direction and the tire circumferential direction. Further, in the adjacent block land portion arrays **5**, the block land portion **4** is adjacent to at least two block land portions by way of the groove portion **6** between the block land portions adjacent in the tire width direction, and two side walls **9, 10** of the adjacent block land portion **4** has projected lengths different from each other, the projected lengths being obtained by projecting the side walls to a line parallel to the tire circumferential direction. Yet further, the block land portions **4** adjacent in the tire width direction are disposed in a point-symmetric manner by way of the groove portion **6** between the block land portions **4** adjacent in the tire width direction.

11 Claims, 21 Drawing Sheets



(52) U.S. Cl.

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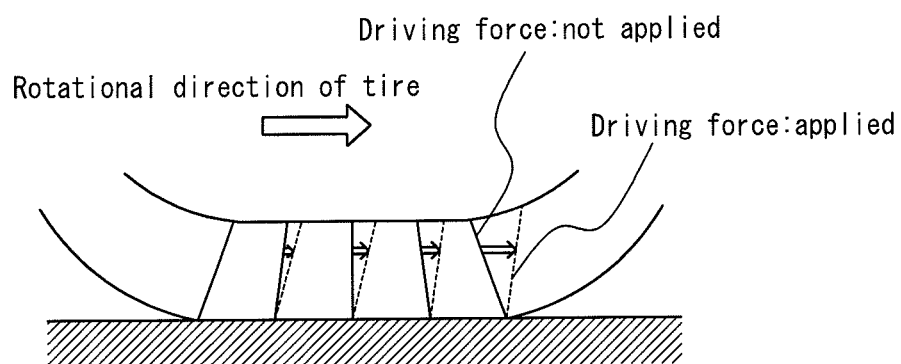
FIG. 1

FIG. 2

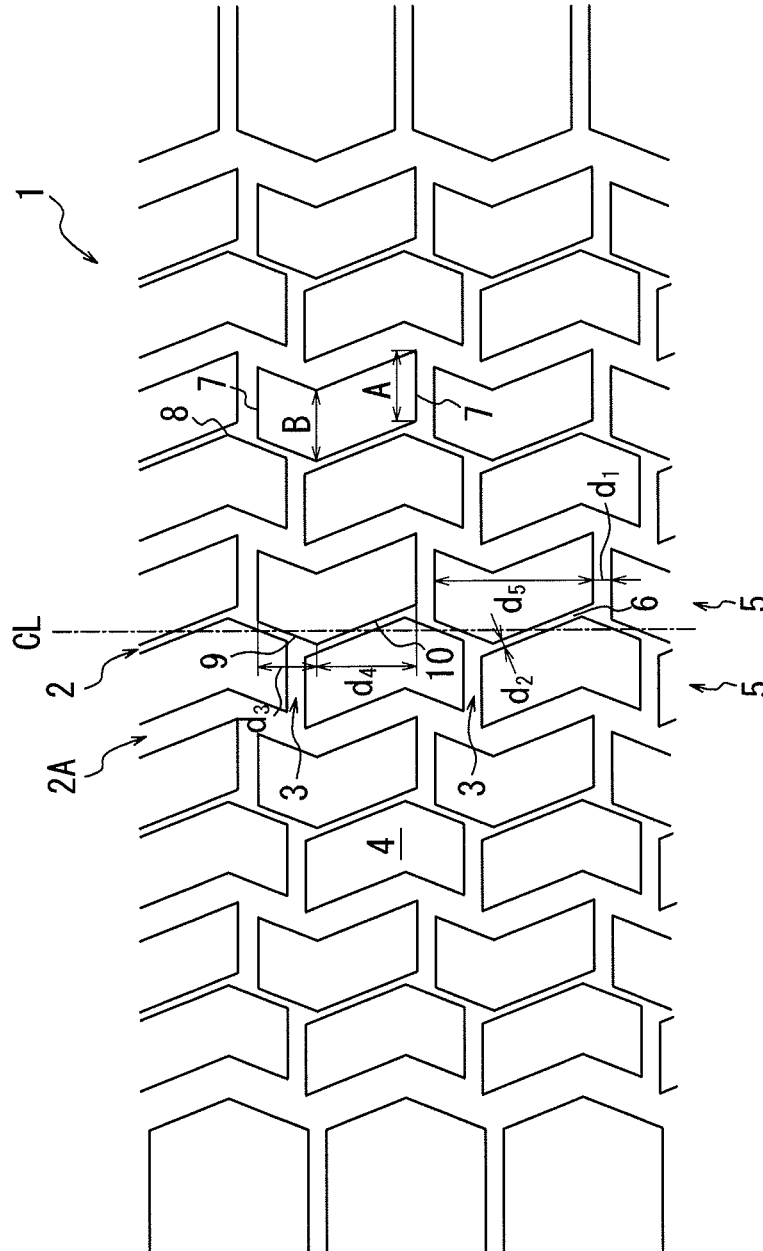


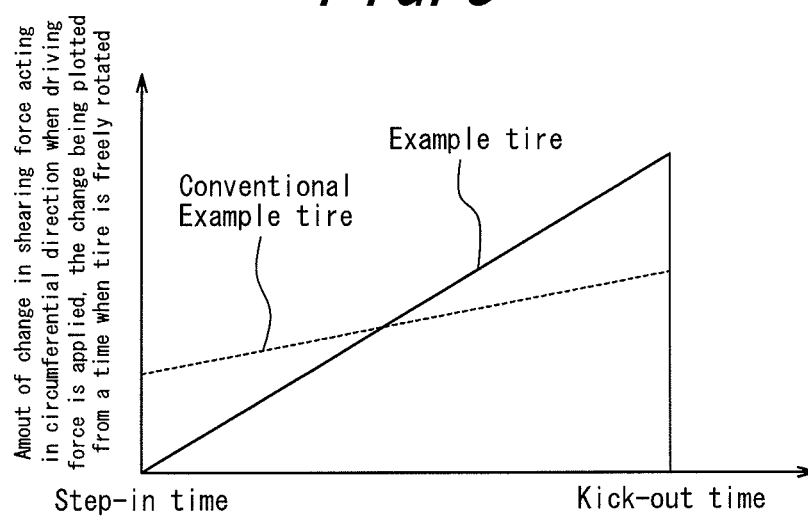
FIG. 3

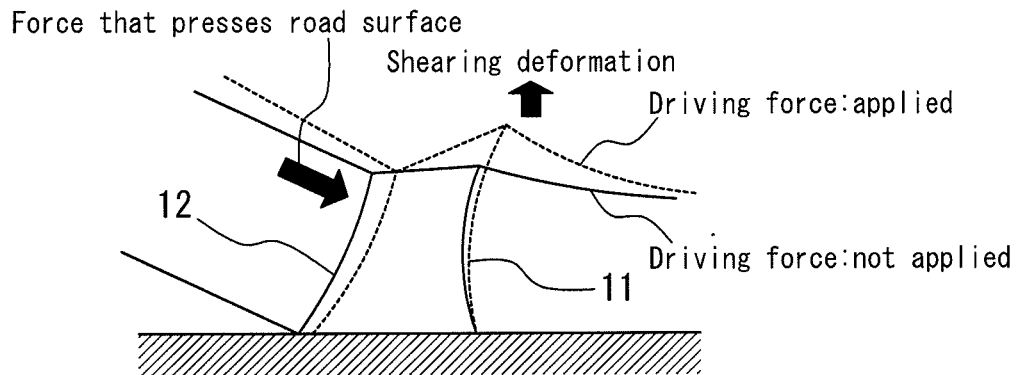
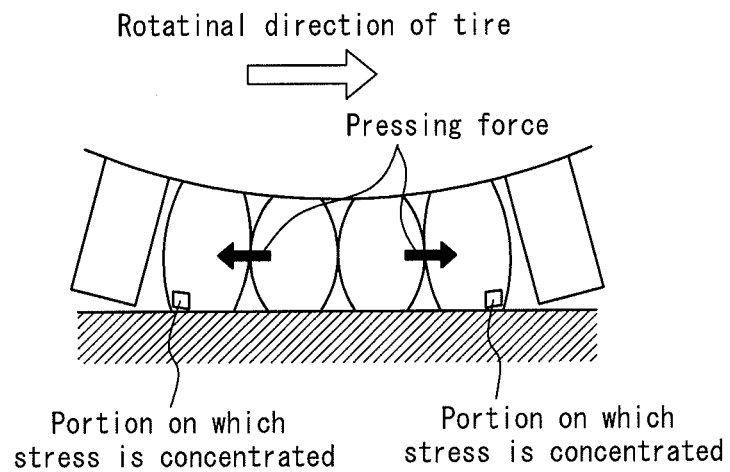
FIG. 4*FIG. 5*

FIG. 6

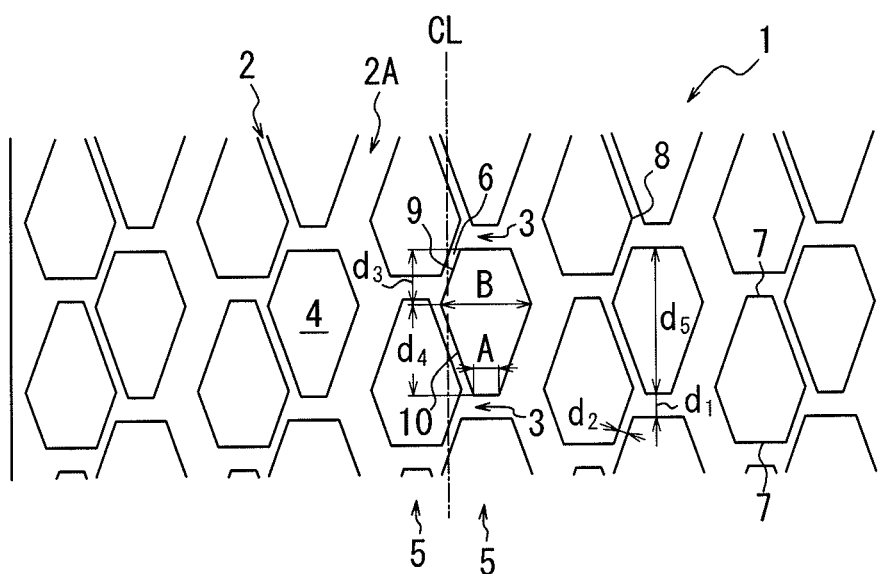


FIG. 7

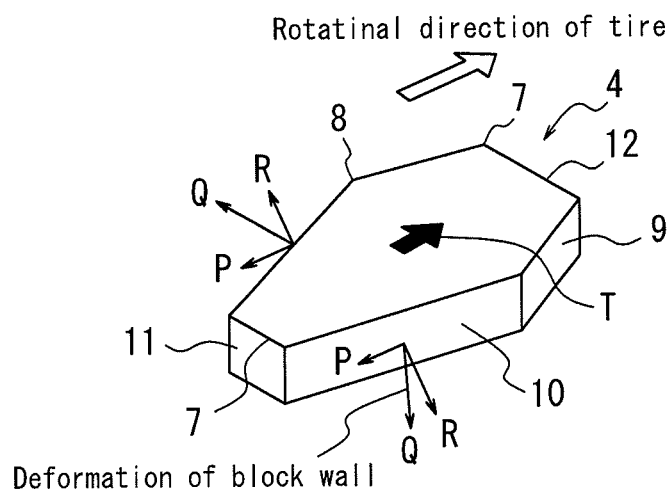
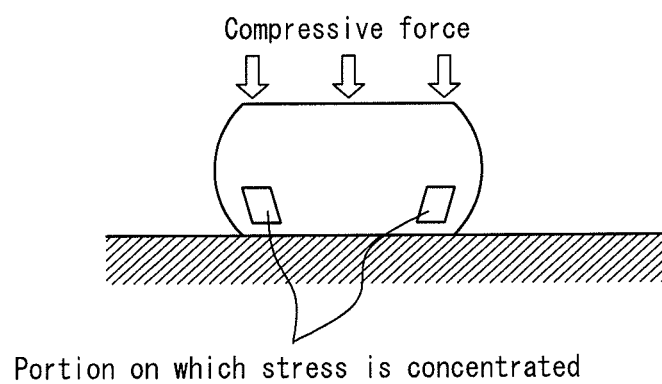


FIG. 8

(a)



(b)

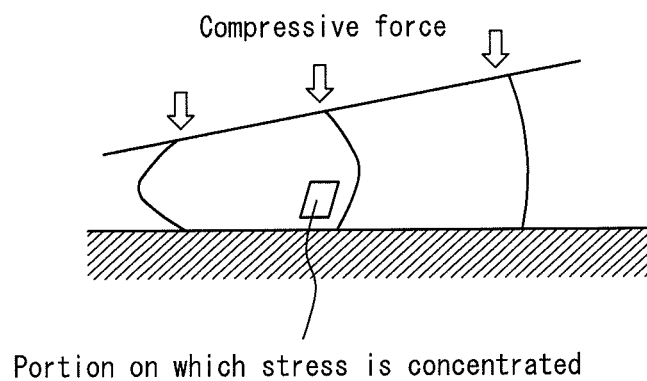


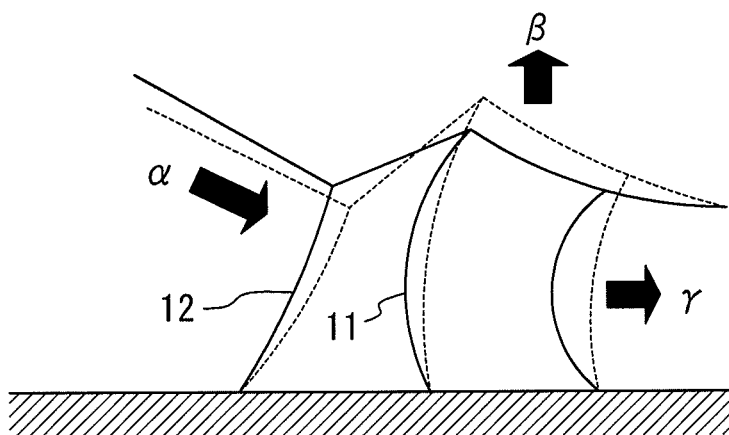
FIG. 9

FIG. 10

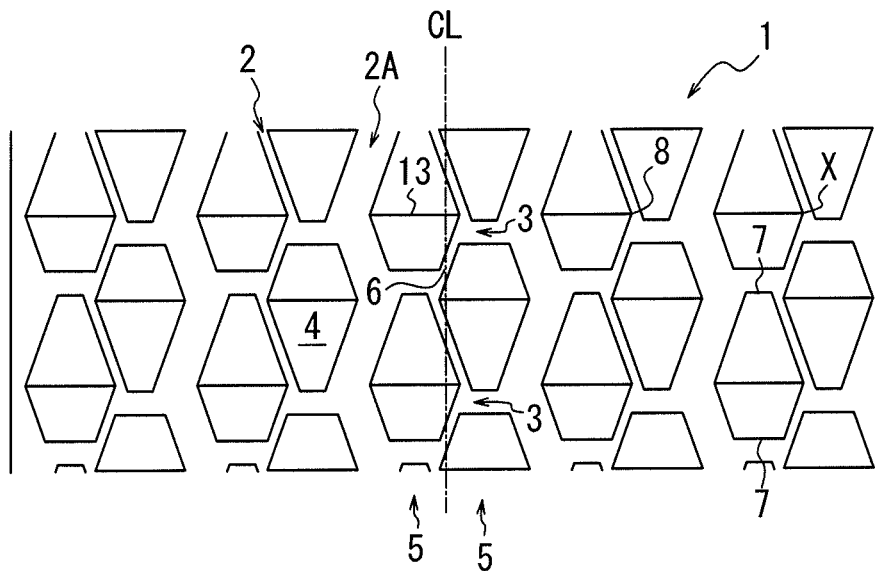


FIG. 11

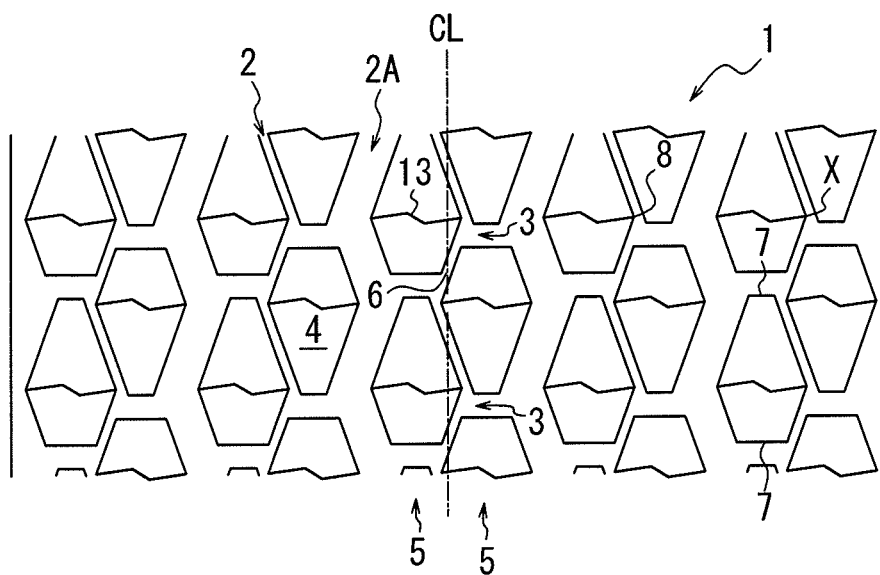


FIG. 12

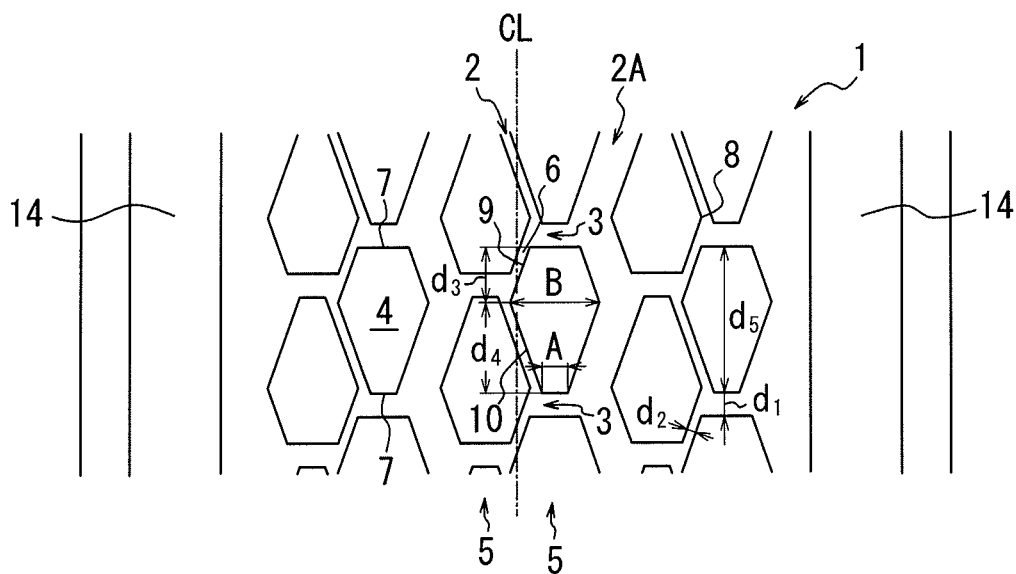


FIG. 13

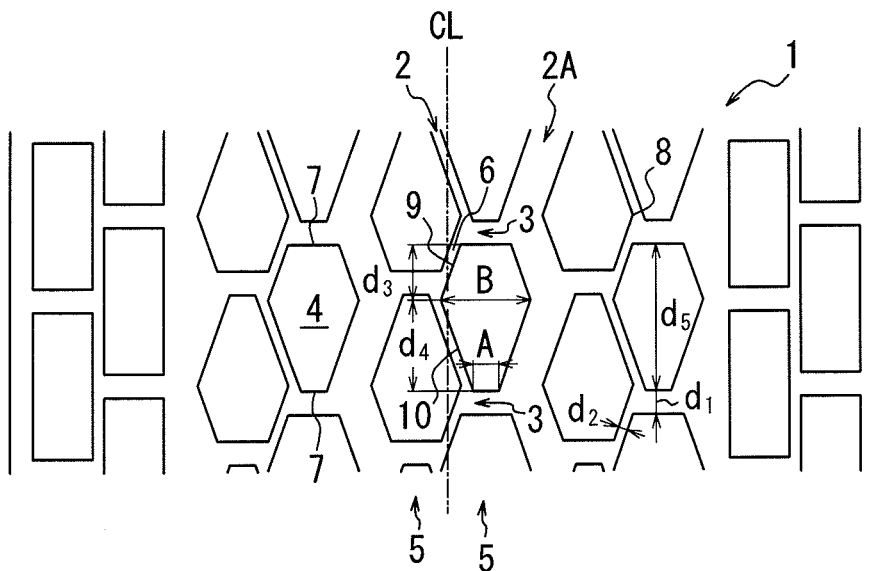


FIG. 14

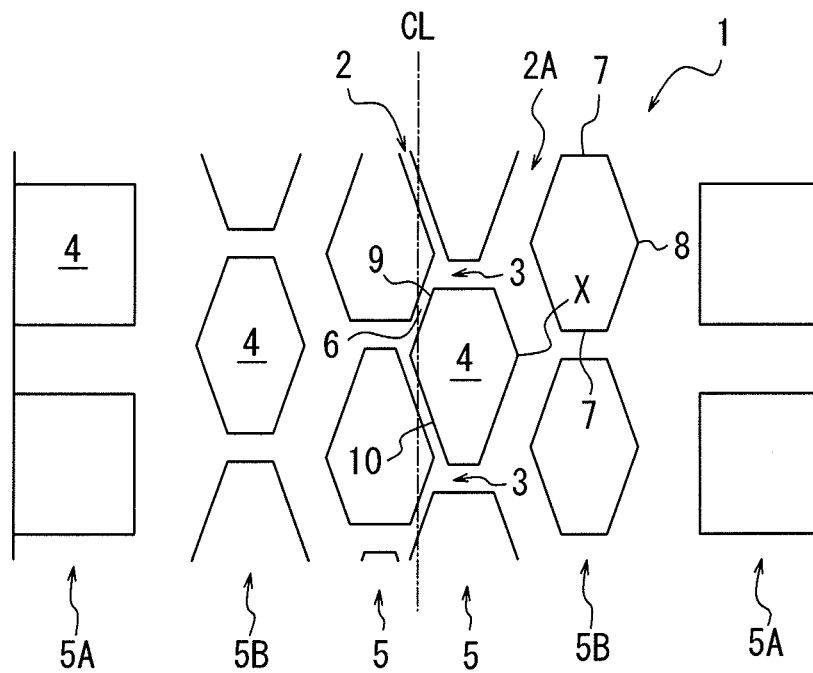


FIG. 15

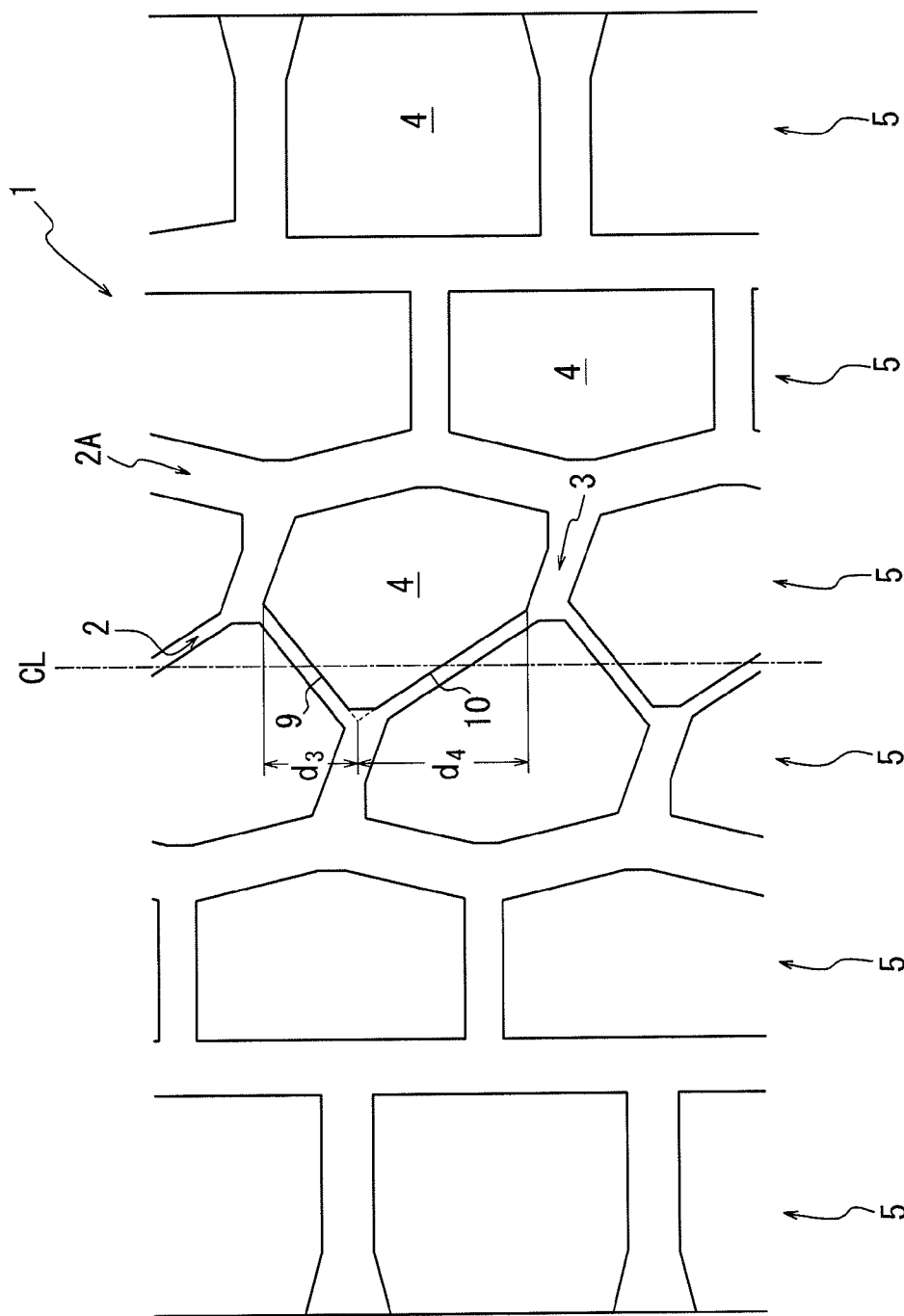


FIG. 16
PRIOR ART

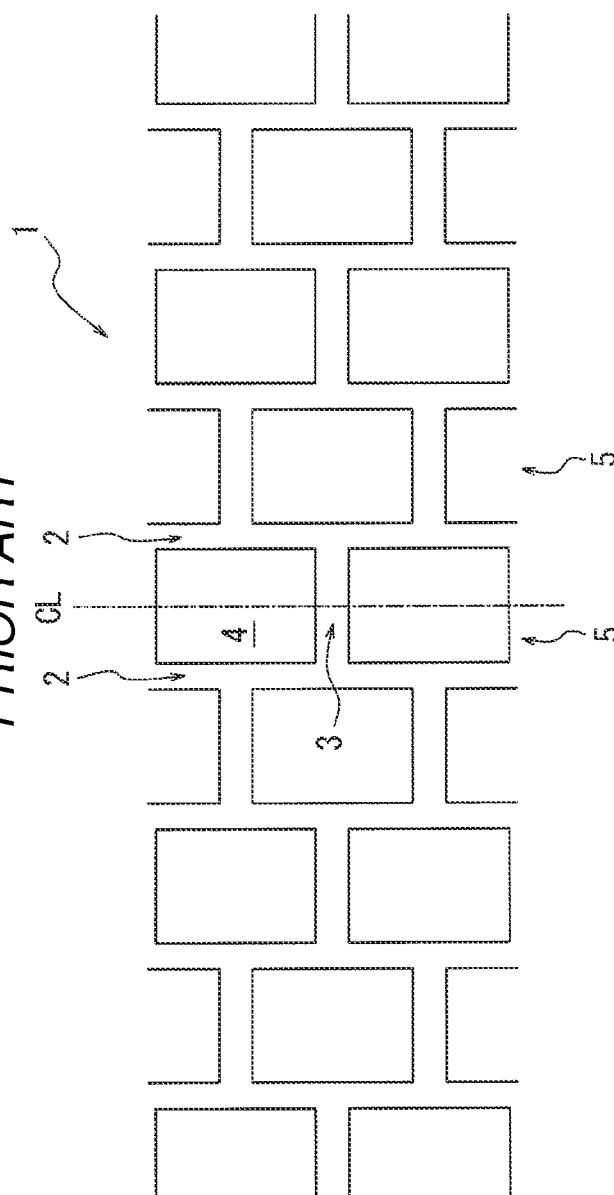


FIG. 17

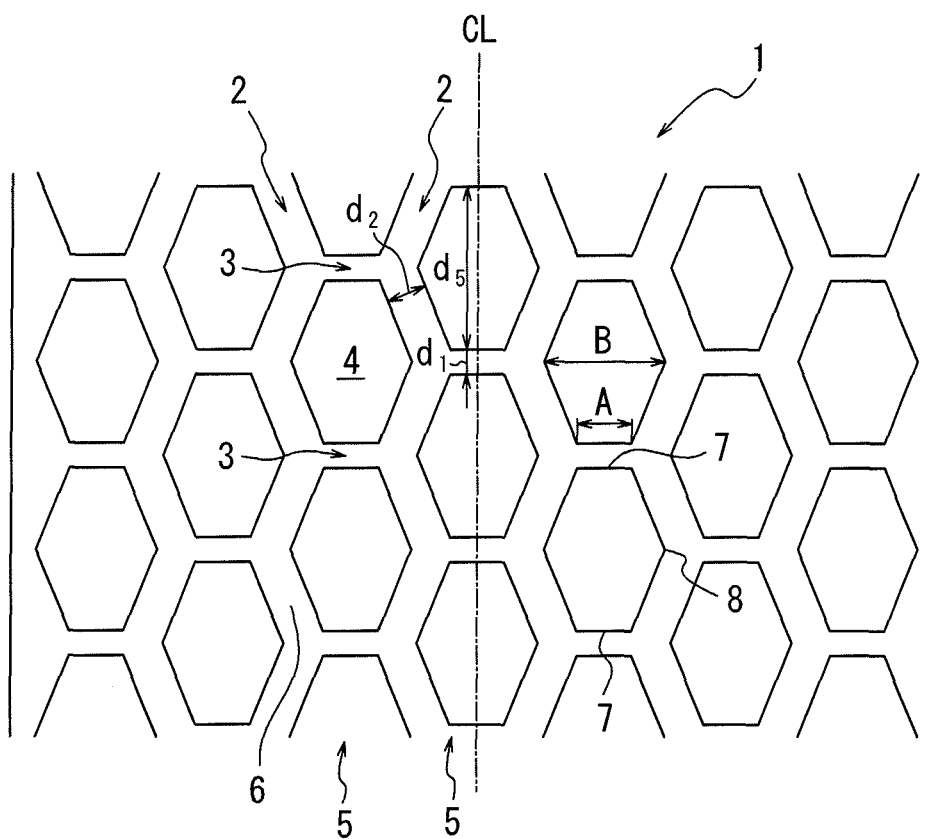


FIG. 18

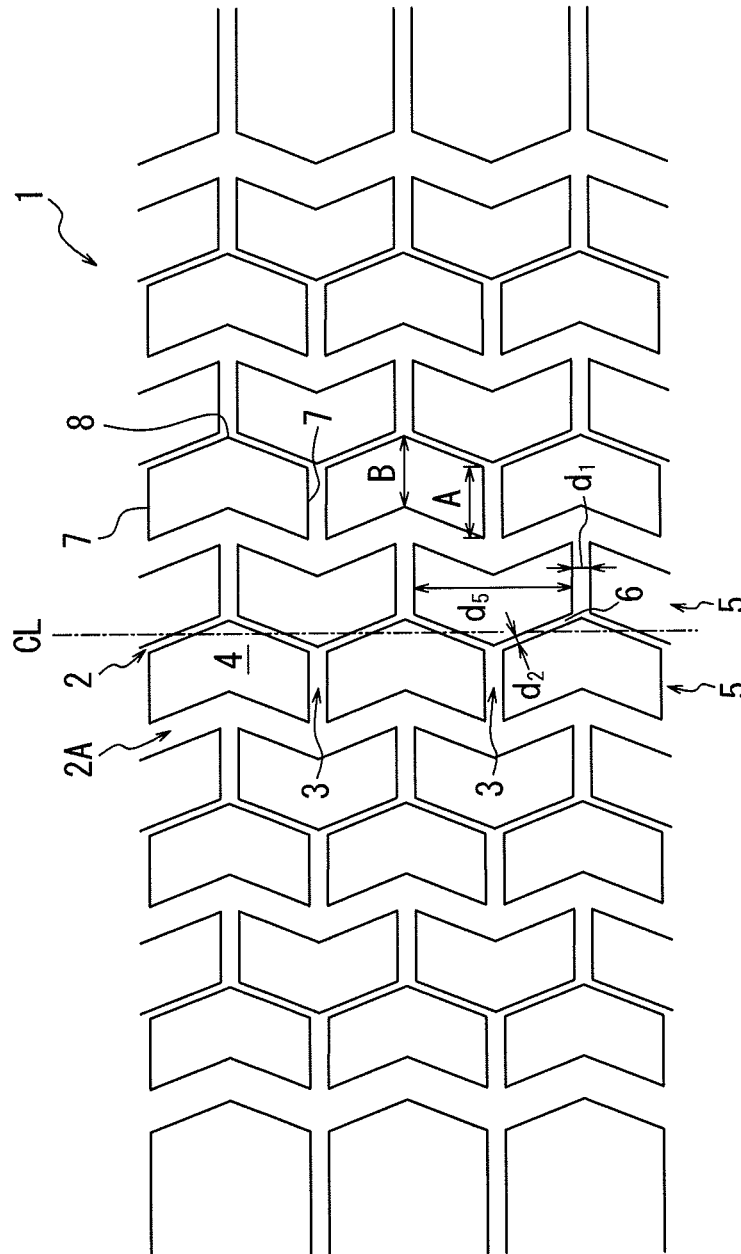


FIG. 19

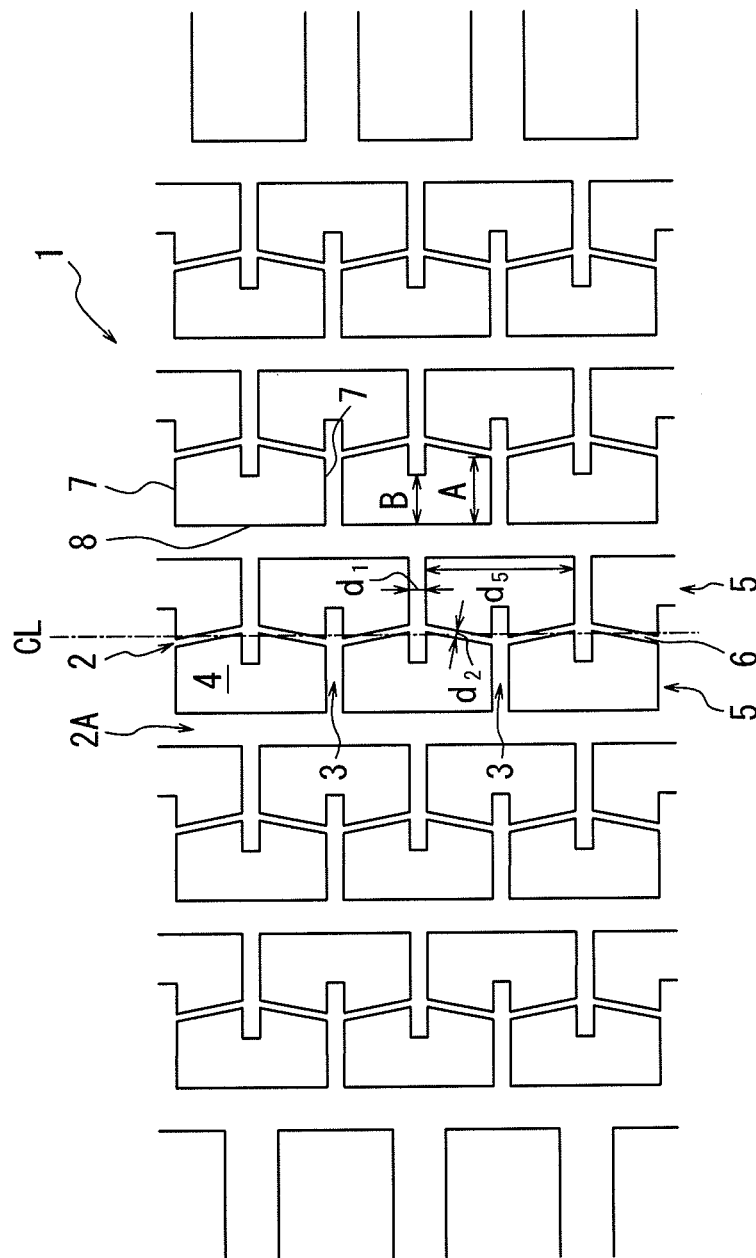


FIG. 20

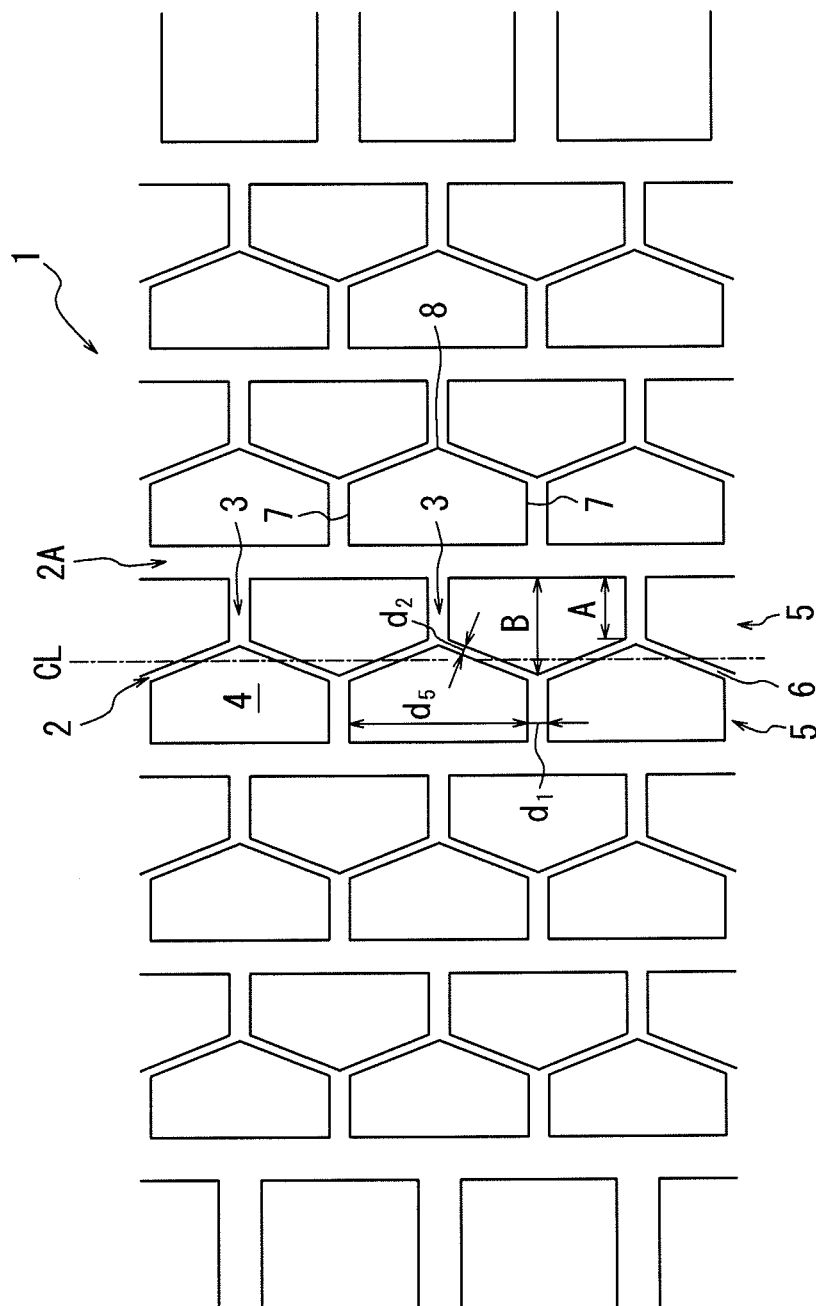


FIG. 21

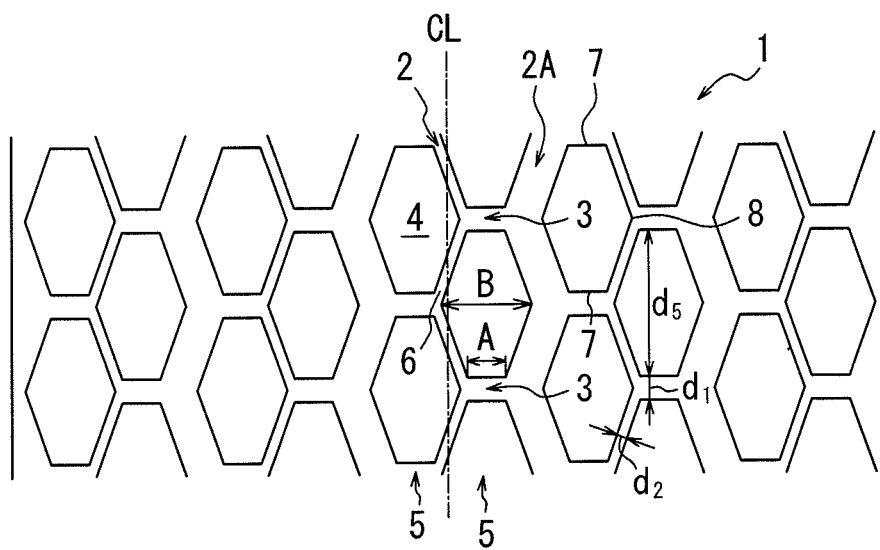


FIG. 22

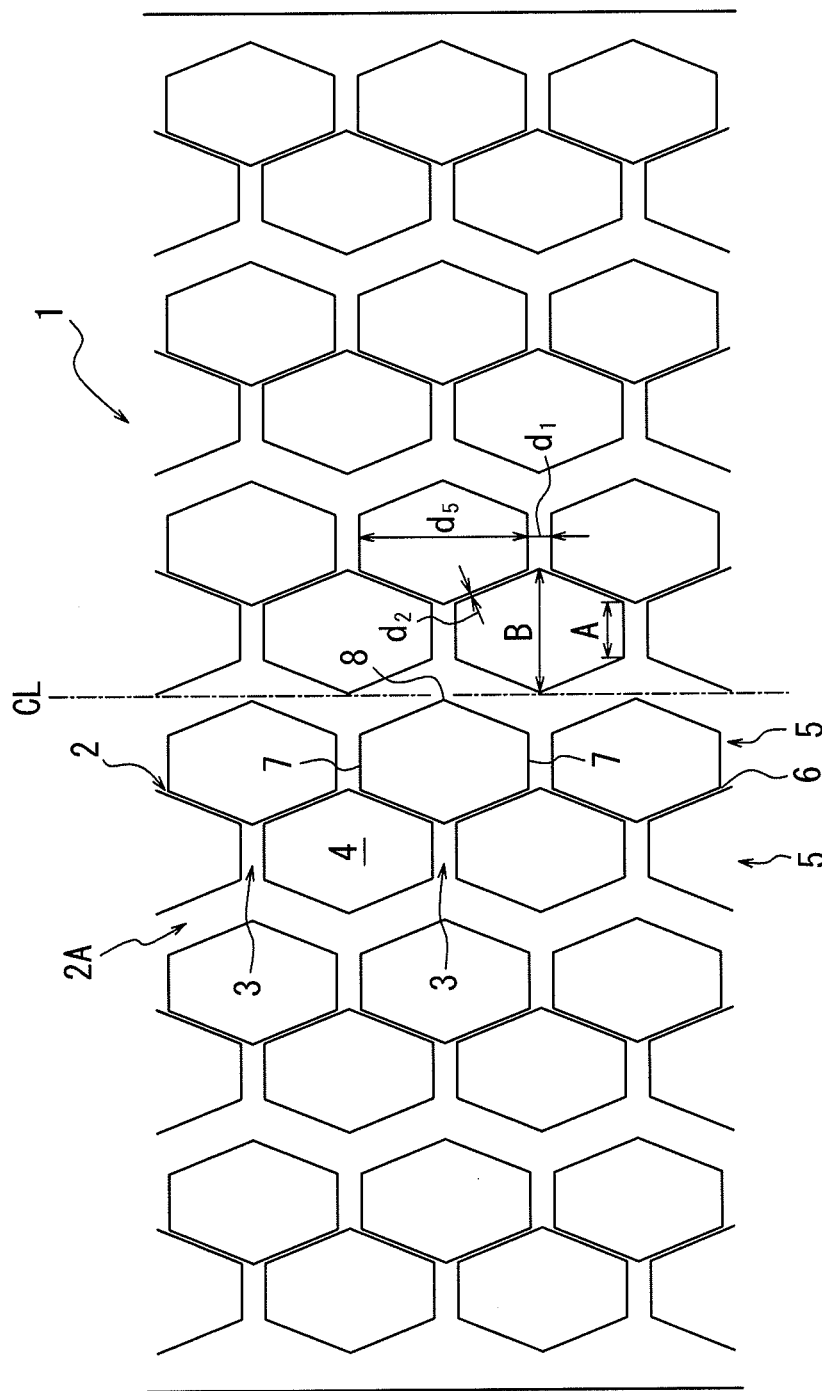


FIG. 23

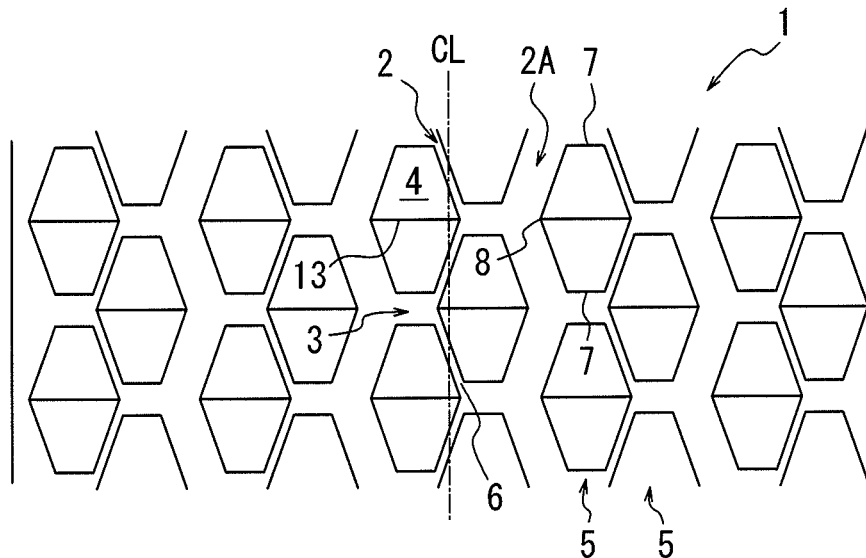


FIG. 24

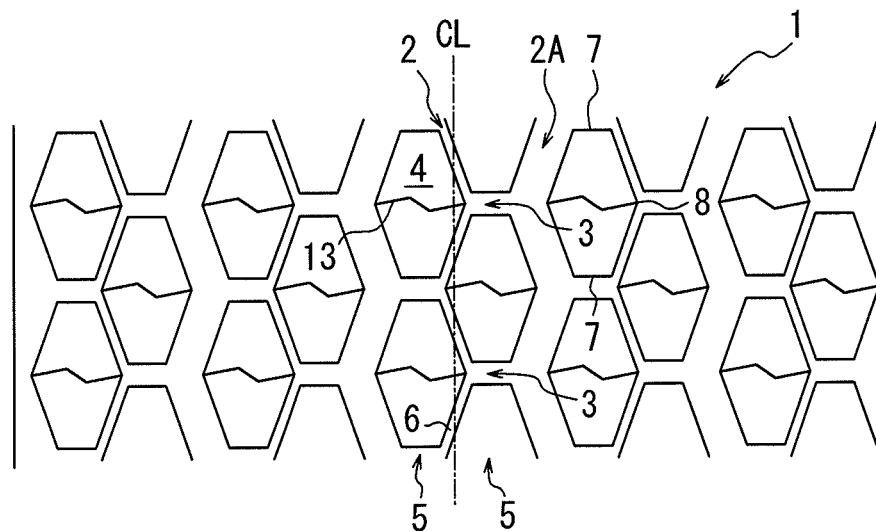


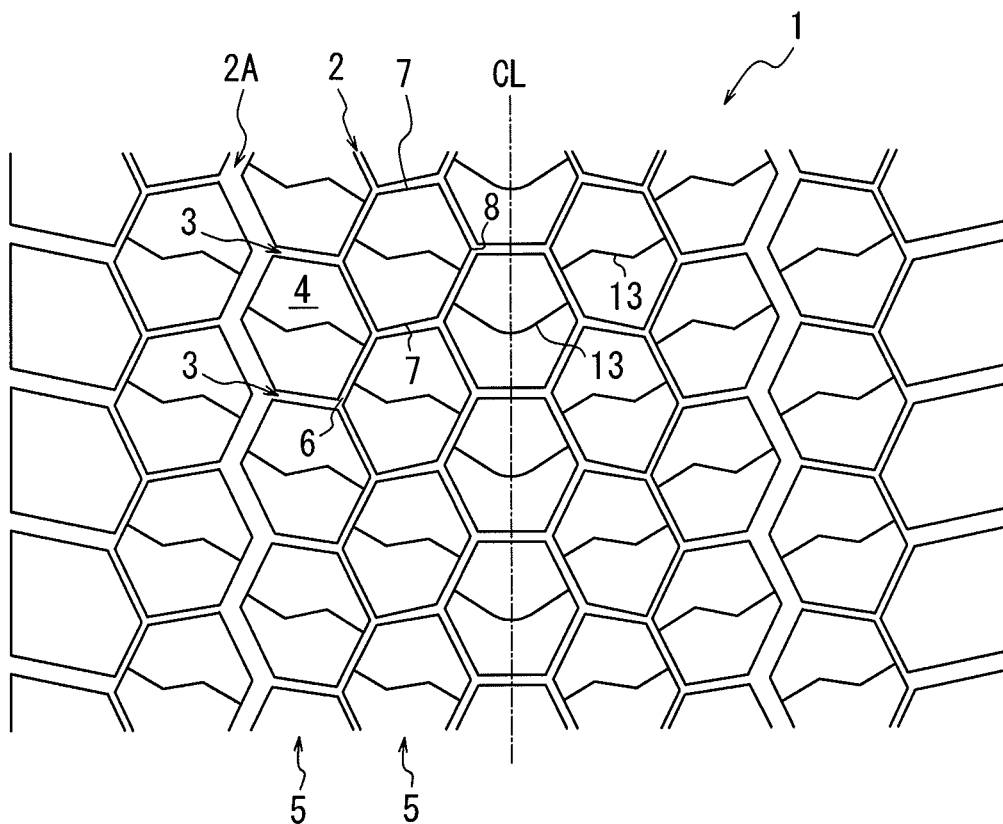
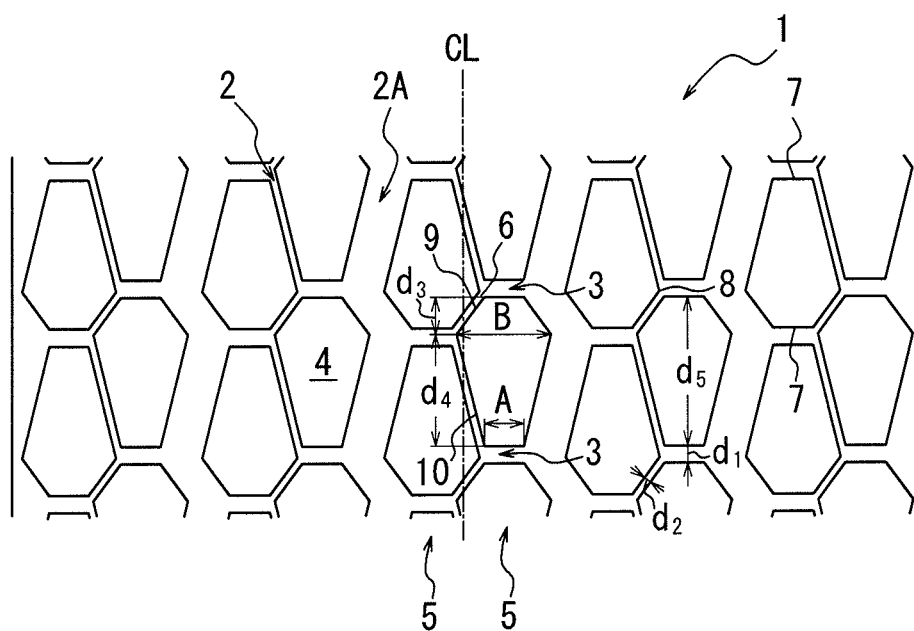
FIG. 25

FIG. 26



1 TIRE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a National Stage of International Application No. PCT/JP2009/006437 filed Nov. 27, 2009, claiming priority based on Japanese Patent Application No. 2008-302524, filed Nov. 27, 2008, the contents of all of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

The present invention relates to a tire, in particular, to a tire for heavy load having, on a tread portion, plural tire-circumferential grooves extending in a tire circumferential direction, and plural lateral grooves each communicating adjacent two tire-circumferential grooves, thereby to define plural block land portion arrays formed by a large number of block land portions, aimed at improving quietness of the tire while improving wear resistance thereof.

RELATED ART

In general, a tire for heavy load is designed to have a high aspect ratio and high belt rigidity of the tire so as to be able to bear considerable amount of weight. Further, in many cases, the tire for heavy load is designed to have a tread pattern in which block land portions are arranged over the entire tread portion so as to be able to travel under various traveling conditions.

The tire for heavy load having such a pattern can bear heavier load as compared with tires for general vehicles, and hence, partial wear resulting from heel and toe wear is likely to occur during travel in proportion to the amount of load that the tire bears. The heel and toe wear refers to wear in which, due to excess deformation of block land portions at the time when the tire is rotated with load, a wear amount of a leading edge (portion that first comes into contact with the ground) of the tire is smaller, and the wear amount of a trailing edge (portion that finally comes into contact with the ground) of the tire in the tire circumferential direction is larger. As a result, there occurs a difference in wear mainly between both ends of the block land portion in the tire circumferential direction, reducing the lifetime of the tire in terms of wear.

Conventionally, for the problem of partial wear as described above, various countermeasures for suppressing the partial wear have been attempted. Of the countermeasure, as disclosed in Patent Document 1 for example, there is proposed an effective method for preventing the partial wear resulting from collapsing deformation, which includes: reducing a depth of a part of lateral grooves defining a block, in other words, forming a bottom-raised portion in each of the lateral grooves to strengthen stress against collapsing deformation of the block land portion toward the tire circumferential direction so as to suppress an increase in the driving force per unit area that the tread portion has to bear.

RELATED ART DOCUMENT

Patent Document

Patent Document 1: Japanese Patent Application Laid-open No. 6-171318

Patent Document 2: Japanese Patent Application Laid-open No. 6-143932

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Patent Document 3: Japanese Patent Application Laid-open No. 8-118917

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

Tires for heavy load for used in trucks or buses have a high aspect ratio and high belt rigidity. Thus, at the time when the tire is rotated with load, there occurs rotation at a belt portion by driving force, and friction at a tread portion that is in contact with the ground, generating a difference in deformation between the belt portion and the tread portion as illustrated in FIG. 1, thereby causing excessive collapse and deformation at the tread portion. This increases the amount of driving force per unit area that the tread portion has to bear, and sliding phenomenon occurs between a block land portion and the ground, causing an increase in the amount of wear of the block land portion. Further, the tire described in Patent Document 1 cannot sufficiently suppress collapsing and deformation of the block land portion at the time of tire rotation with load. Therefore, the tire described in Patent Document 1 cannot suppress the increase in the amount of wear of the block land portion caused by the sliding phenomenon, and the problem concerning wear resistance is left unsolved. Further, in general, by increasing the rigidity of a rubber forming the block land portion to suppress the excess collapsing and deformation of the block land portion, it is possible to effectively suppress the amount of wear of the block land portion. However, this excessively increases the rigidity of the block land portion, possibly causing the block land portion to break due to chip or crack at the time when the tire is rotated with load. Yet further, for such a tire, sufficient attention has not been paid to quietness, and in recent years, there is an increasing demand for improvement in comfortability in a car, whereby improvement for comfortability of tires is further required for the tires. Note that Patent Documents 2 and 3 describe tires having tread patterns capable of improving the quietness. However, there was room for improvement for these tires in terms of wear resistance.

Therefore, an object of the present invention is to provide a tire exhibiting both improved wear resistance and improved quietness, by optimizing shapes of block land portions and positional arrangement thereof.

Means for Solving the Problem

To achieve the object described above, the present invention provides a tire having, on a tread portion, a plurality of circumferential grooves extending in a tire circumferential direction, and plural lateral grooves each communicating adjacent two circumferential grooves, thereby defining a plurality of block land portion arrays formed by a large number of block land portions, wherein: between block land portion arrays located adjacent to each other while sandwiching the circumferential groove, the block land portions constituting said block land portion arrays are arranged so as to be positionally displaced from each other in the tire circumferential direction; a groove portion between the block land portions adjacent in the tire width direction extends obliquely with respect to the tire width direction and the tire circumferential direction; a distance between the block land portions adjacent in the tire width direction is shorter than a distance between the block land portions adjacent in the tire circumferential direction; in the adjacent block land portion arrays, the block land portion is adjacent to at least two block land portions by way of a groove portion between block land portions adjacent

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in the tire width direction; two side walls of the adjacent block land portion have projected lengths different from each other, the projected lengths being obtained by projecting the side walls to a line parallel to the tire circumferential direction; and, the block land portions adjacent in the tire width direction are disposed in a point-symmetric manner by way of the groove portion between the block land portions adjacent in the tire width direction. In this specification, the term "groove portion" refers to a part of the circumferential groove, and a groove extending between the block land portions adjacent in the tire width direction. The expression "positionally displaced" means arrangement in which beginning points of the respective block land portions adjacent in the tire width direction are arranged differently from each other at pitches in the tire circumferential direction, so that end portions of block land portions in the circumferential direction are different between the block land portions adjacent in the tire width direction. Further, the expression "arranged in a point-symmetric manner" means arrangement in a point symmetry about a given position located on the groove portion between the block land portions adjacent in the tire width direction and located between the opposing side walls.

Further, it is preferable that, of the two side walls having the projected lengths different from each other, a projected length of one side wall has a length in the range of 1.2 to 6.0 times a projected length of the other side wall.

Yet further, it is preferable that the lateral groove extends obliquely with respect to the tire width direction. At this time, it is preferable that the lateral groove extends obliquely with respect to the tire width direction at an angle in the range of 5 to 45°.

Still yet further, it is preferable that a length of the block land portion in the widthwise cross section of the tire increases from both end portions of the block land portion in the tire circumferential direction toward the central portion of the block land portion. In this specification, the term "central portion of the block land portion" means a portion extending from the central position of the block land portion in the tire circumferential direction toward both ends of the block land portion up to the range of 40% of the length of the block land portion in the tire circumferential direction, and, more specifically, means an area in which 30% from the respective end portions of the block land portion in the circumferential direction is excluded.

Still yet further, it is preferable that a distance between the block land portions adjacent in the tire circumferential direction with respect to a distance between the block land portions adjacent in the tire width direction is in the range of 1:0.85 to 1:0.3.

Still yet further, it is preferable that a length of the block land portion in the tire circumferential direction with respect to a distance between the block land portions adjacent in the tire circumferential direction is in the range of 1:0.25 to 1:0.05.

Still yet further, it is preferable that a distance between the block land portions adjacent in the tire width direction is in the range of 1.0 to 5.0 mm.

Still yet further, it is preferable that a distance between the block land portions adjacent in the tire circumferential direction is in the range of 3.0 to 10.0 mm.

Still yet further, it is preferable that the block land portion is provided with a narrow groove communicating, in the tire width direction, two circumferential grooves adjacent to said block land portion.

Still yet further, it is preferable that the narrow groove is open to the circumferential groove at the central portion of the block land portion.

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Still yet further, it is preferable that the length of the narrow groove in the tire circumferential direction is in the range of 5 to 20% of a depth of the lateral groove.

Effect of the Invention

According to the present invention, it is possible to provide a tire exhibiting both improved wear resistance and improved quietness, by optimizing shapes of block land portions and positional arrangement thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram illustrating a relationship between the presence/absence of a load by driving force and positions to which a tread portion moves.

FIG. 2 is a development view illustrating a part of a typical tread portion of a tire according to the present invention.

FIG. 3 is a diagram illustrating a shearing force from a road surface when driving force is applied.

FIG. 4 is a diagram illustrating deformation of adjacent block land portions when the driving force is applied.

FIG. 5 is a diagram illustrating deformation of the block land portions in the case where block land portions adjacent in the tire circumferential direction are excessively close to each other.

FIG. 6 is a development view illustrating a part of another tread portion of a tire according to the present invention.

FIG. 7 is a perspective view of a block land portion illustrated in FIG. 6 (reference character T: deformation of a rubber from a trailing edge toward a leading edge due to pressing in the oblique direction).

FIG. 8(a) is a diagram illustrating a block land portion that is pressed against and is in contact with the road surface in a horizontal manner, and

FIG. 8(b) is a diagram illustrating a block land portion that is pressed against and is in contact with the road surface in an oblique manner.

FIG. 9 is a diagram illustrating deformation of an adjacent block land portion when driving force is applied. (reference character α : increase in shearing deformation at a step-in time, reference character β : increase in the amount of rise, and reference character γ : decrease in deformation of the tread rubber toward a direction opposite to a rotational direction).

FIG. 10 is a development view illustrating a part of another tread portion of the tire according to the present invention.

FIG. 11 is a development view illustrating a part of another tread portion of the tire according to the present invention.

FIG. 12 is a development view illustrating a part of another tread portion of the tire according to the present invention.

FIG. 13 is a development view illustrating a part of another tread portion of the tire according to the present invention.

FIG. 14 is a development view illustrating a part of another tread portion of the tire according to the present invention.

FIG. 15 is a development view illustrating a part of another tread portion of the tire according to the present invention.

FIG. 16 is a development view illustrating a part of a tread portion of a Conventional Example tire.

FIG. 17 is a development view illustrating a part of a tread portion of a Comparative Example tire 1.

FIG. 18 is a development view illustrating a part of a tread portion of a Comparative Example tire 2.

FIG. 19 is a development view illustrating a part of a tread portion of a Comparative Example tire 3.

FIG. 20 is a development view illustrating a part of a tread portion of a Comparative Example tire 4.

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FIG. 21 is a development view illustrating a part of a tread portion of a Comparative Example tire 5.

FIG. 22 is a development view illustrating a part of a tread portion of a Comparative Example tire 6.

FIG. 23 is a development view illustrating a part of a tread portion of a Comparative Example tire 7.

FIG. 24 is a development view illustrating a part of a tread portion of a Comparative Example tire 8.

FIG. 25 is a development view illustrating a part of a tread portion of a Comparative Example tire 9.

FIG. 26 is a development view illustrating a part of a tread portion of an Example tire.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinbelow, an embodiment of the present invention will be described with reference to the drawings. FIG. 2 is a development view illustrating a part of a typical tread portion of a tire according to the present invention. FIG. 3 is a diagram illustrating a shearing force from a road surface when driving force is applied. FIG. 4 is a diagram illustrating deformation of adjacent block land portions when the driving force is applied. FIG. 5 is a diagram illustrating deformation of the block land portions in the case where block land portions adjacent in the tire circumferential direction are excessively close to each other. FIG. 6 is a development view illustrating a part of another tread portion of a tire according to the present invention. FIG. 7 is a perspective view of a block land portion illustrated in FIG. 6. FIG. 8(a) is a diagram illustrating a block land portion that is pressed against and is in contact with the road surface in a horizontal manner, and FIG. 8(b) is a diagram illustrating a block land portion that is pressed against and is in contact with the road surface in an oblique manner. FIG. 9 is a diagram illustrating deformation of an adjacent block land portion when driving force is applied. FIG. 10 through FIG. 15 are development views each illustrating another tread portion of the tire according to the present invention.

As illustrated in FIG. 2, the tire according to the present invention has, on a tread portion 1, plural circumferential grooves 2 extending in a tire circumferential direction and plural lateral grooves 3 each communicating two adjacent circumferential grooves 2, thereby to define plural block land portion arrays 5 formed by a large number of block land portions 4. Further, between adjacent block land portion arrays 5, the block land portions 4 constituting the block land portions are arranged so as to be positionally displaced from each other in the tire circumferential direction, and a groove portion 6 existing between the block land portions adjacent in the tire width direction extends so as to be oblique to the tire width direction and the tire circumferential direction. Yet further, a distance d_2 between the block land portions adjacent in the width direction of the tire is shorter than a distance d_1 between block land portions adjacent in the circumferential direction of the tire. Yet further, a length of the block land portion 4 in the widthwise cross section of the tire is constant from both end portions 7, 7 of the block land portion 4 in the circumferential direction toward a central portion 8 of the block land portion 4. Still yet further, in the adjacent block land portion arrays 5, one block land portion 4 is adjacent to two block land portions 4 via a groove portion 6 between block land portion 4 adjacent in the tire width direction. Two side walls 9, 10 of the adjacent block land portion 4 have projected lengths d_3 and d_4 different from each other, each of which projected lengths is a length obtained by projecting each of the side walls to a line parallel to the tire

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circumferential direction, and, the projected length d_3 is shorter than the projected length d_4 . Still yet further, the block land portions 4 adjacent in the tire width direction are arranged in a point-symmetric manner via the groove portion 6 between the block land portions adjacent in the tire width direction.

The present inventor found that an increase in belt rigidity leads to a decrease in an area where a tread surface is brought into contact with a road surface, and hence, shearing force in the tire circumferential direction excessively increases at the time of kick-out of the tread that causes sliding wear to occur, which causes wear resistance to reduce. FIG. 3 shows a change in the shearing force (force acting in the driving direction and on the road-contacting surface of the tire) acting in the circumferential direction from the step-in time to the kick-out time at given positions of the block land portion in a road-contacting state while the driving force is being applied, the change being plotted from the time when load by driving force is not applied to the tire. As shown in the solid line, in the conventional tire, at the step-in time, the shearing force in the circumferential direction is almost equal to the shearing force acting at the time when driving force is not applied, and then, monotonously increases toward the kick-out time. The total amount of those forces generated from the step-in time to the kick-out time (integral value of the shearing force in the circumferential direction generated from the step-in time to the kick-out time) makes a vehicle accelerate, functioning as the force acting on a tire axis. If the ground-contacting surface decreases, the decrease of the integral value resulting from said decrease in the area is compensated with change in the force per unit area being steeper from the step-in time to the kick-out time. As a result, the shearing force in the circumferential direction at the kick-out time increases, which reduces the wear resistance. The present inventor made a keen study on the basis of an idea that the integral value above can be compensated by generating the shearing force in the circumferential direction from the step-in time (change from the time when driving force is not applied) so as to decrease the shearing force in the circumferential direction at the kick-out time, as shown in the broken line in FIG. 3. As a result, it is found that the characteristic shown in the broken line in FIG. 3 can be obtained by efficiently generating the force at the step-in time such that: as shown in FIG. 4, at the time when the driving force is applied, the shearing deformation is generated at a block land portion that has already been stepped in; as the deformation increases, the block land portion rises accordingly, which causes reaction; the next block land portion is pressed on the road surface side by the reaction; and the reaction causes the deformation of the next block land portion to increase. Although it is also found that this phenomenon effectively works by reducing a distance between the block land portions in the circumferential direction of the tire, the block land portions come into contact with each other at the time when the tire is brought into contact with the road surface, in the case where the distance between the block land portions in the circumferential direction of the tire is too short, as illustrated in FIG. 5. This causes force to be generated in the same direction as that of the driving force at the kick-out time, which adversely deteriorates the wear resistance. In this respect, the present inventor sought a configuration that can effectively utilize the action between the block land portions while eliminating the effect caused by the contact between the block land portions in the circumferential direction of the tire, and as a result, found the configuration of the present invention. The present invention is configured such that: between two block land portion arrays 5, 5 adjacent to each other in the width direction of the tire, the block land

portions 4 constituting the block land portion arrays are arranged so as to be positionally displaced from each other in the tire circumferential direction; a groove portion 6 between block land portions adjacent to each other in the tire width direction extends obliquely with respect to the tire width direction and the tire circumferential direction; a distance d_2 between block land portions adjacent to each other in the tire width direction is shorter than a distance d_1 between block land portions adjacent to each other in the tire circumferential direction, whereby it is possible to suppress an expansion component (FIG. 5) of a rubber caused by the contact of the block land portions 4, 4 adjacent to each other in the tire circumferential direction, while effectively bearing the driving force at the step-in time using reaction between the block land portions 4, 4 by making the most of the configuration in which block land portions 6 between the block land portions adjacent to each other in the tire width direction extends obliquely with respect to the tire width direction and the tire circumferential direction and the distance between the block land portions is shorter. With this configuration, a gradient of shearing force in the circumferential direction of the tire from the step-in time to the kick-out time is made small, so that the sliding wear can be effectively suppressed.

Additionally, the present inventor made a keen study on improving quietness with the configuration described above, and as a result, found the following. It is found that, when a tire, in particular, a tire for heavy load having a block pattern in which block land portions are arranged at equal pitches is mounted to a vehicle, and the vehicle travels at a speed of 70 to 80 km per hour, which is a center speed at the time of long-distance travel, the quietness deteriorates due to the fact that an air-column resonance noise occurring from the circumferential groove and having its peak value in a frequency band in the vicinity of 800 Hz is overlapped with a secondary pitch noise occurring at the time when the lateral grooves are brought into contact with the road surface at equal intervals and having its peak in a frequency band in the vicinity of 800 Hz, and those noises produce the synergistic effect. Therefore, the present inventor found that, by employing the configuration described above, and further employing the configuration in which, in the block land portions 4 in the block land portion arrays 5 adjacent in the tire width direction, side walls 9 and 10, which are two faces facing the groove portion 6 between the block land portions adjacent in the tire width direction, are formed so as to have projected lengths d_3 and d_4 different from each other, each of which projected lengths is a length obtained by projecting the side walls to a line parallel to the tire circumferential direction, it is possible to make the circumferential pitches of the lateral grooves 3 arranged at different intervals between the block land portions 4, 4 in the adjacent block land portion arrays 5. This reduces the secondary pitch noise, and shifts the peak value of the secondary pitch noise with respect to the peak value of the air-column resonance noise, whereby it is possible to effectively improve the quietness. Further, by disposing the block land portions 4 adjacent in the tire width direction in a point-symmetric manner via the groove portion 6 between the block land portions 4 adjacent in the tire width direction, the tire can be mounted to the vehicle in any rotational direction, whereby it is possible to improve convenience of the tire.

At this time, it is preferable that the projected length d_3 of the one side wall 9 is 1.2 to 6.0 times the projected length d_4 of the other side wall 10. This is because, in the case where the projected length d_3 of the side wall 9 has a length greater than 6 times the projected length d_4 of the other side wall 10, variations in the magnitude of reaction between the block land portions 4, 4 as described above are undesirably great,

and hence, the driving force to be born at the step-in time cannot be effectively dispersed in some block land portions 4, whereby there is a possibility that the sliding wear cannot be effectively suppressed. On the other hand, in the case where the projected length d_3 of the side wall 9 has a length less than 1.2 times the projected length d_4 of the other side wall 10, the circumferential pitches of the lateral grooves 3 are undesirably close to equal intervals, and hence, there is a possibility that the effect of reducing the secondary pitch noise as described above and shifting the peak values cannot be sufficiently obtained.

Further, it is preferable that the block land portions 4 adjacent in the tire width direction are arranged so as to be positionally displaced by a half pitch in the tire circumferential direction. This is because, by positionally displacing the block land portions 4 by the half pitch, the deformation force resulting from collapsing and deforming when the tire is rotated with load can be effectively transferred to a block land portion 4 adjacent in the tire width direction, and hence, the driving force per unit area that the tread portion 1 has to bear can be reduced, whereby it is possible to prevent the wear caused by the sliding phenomenon of the block land portions 4 with respect to the road surface. This makes it possible to reduce the gradient of the shearing force in the tire circumferential direction from the step-in time to the kick-out time and also reduce the shearing force at the kick-out time when the sliding wear occurs, so that the sliding wear can be reduced. Note that the effect of the present invention may be obtained even if the block land portions 4 adjacent in the tire width direction are arranged so as to be positionally displaced by pitches other than by the half pitch in the tire circumferential direction. Further, from the viewpoint of further effectively suppressing the sliding wear, it is preferable that the inclined angle of the direction in which the groove portion 6 between the block land portions adjacent in the tire width direction extends with respect to the tire circumferential direction is in the range of 15° to 70° . Further, from the viewpoint of obtaining a mutual effect between the block land portions as described above and maintaining said effect until the end of the wear, it is preferable for a depth of the groove portion 6 between the block land portions adjacent in the tire width direction to be in the range of 60 to 100% of a groove depth of the circumferential groove 2A.

Further, it is preferable that the lateral groove 3 extends obliquely with respect to the tire width direction. This is because, by making the lateral groove 3 extend obliquely with respect to the tire width direction, the leading edge 12 of the block land portion 4 gradually comes into contact with the road surface when the tire is rotated with load. This reduces the pitch noise, which is the hitting sound occurring at the step-in time of the block land portion 4, thereby improving the quietness. At this time, it is preferable that the inclined angle of the direction in which the lateral groove 3 extends with respect to the tire width direction is in the range of 5° to 45° . This is because, in the case where the inclined angle of the direction in which the lateral groove 3 extends with respect to the tire width direction is less than 5° , the leading edges 12 of the block land portions 4 come into contact with the road surface substantially at the same time when the tire is rotated with load. Therefore, the increase in the pitch noise, which is the hitting sound as described above, cannot be effectively suppressed, and there is a possibility that the effect obtained by forming the lateral groove 3 so as to extend in the oblique direction cannot be sufficiently obtained. On the other hand, in the case where the inclined angle of the direction in which the lateral groove 3 extends with respect to the tire width direction exceeds 45° , the rigidity at an area in the

vicinity of the lateral groove 3 of the block land portion 4 deteriorates, and there is a possibility that the block land portion 4 in said area breaks when the tire is rotated with load.

Yet further, as illustrated in FIG. 6 and FIG. 7, it is preferable that a length of the block land portion 4 in the widthwise cross section of the tire increases from both end portions 7, 7 of the block land portion 4 in the tire circumferential direction toward the central portion 8 of the block land portion 4. The present inventor made a keen study on wear of the block land portion in the case where a tire having block land portions, in particular, a tire for heavy load having a high aspect ratio is used in drive wheels, and as a result, found the following. More specifically, if the block land portion is pressed against and is brought into contact with the road surface in a horizontal manner, a stress resulting from incompressibility of rubber is concentrated on a leading edge and a trailing edge of the block land portion as shown in FIG. 8(a). However, at the time of the kick-out time when tread wear occurs due to slippage of the tread portion, and the tread portion is pressed obliquely against the road surface because of existence of a belt, so that the stress resulting from the incompressibility of rubber is born by the central portion of the block land portion as shown in FIG. 8(b). In particular, in the case where the tire has a high aspect ratio and high belt rigidity, the tread portion is further strongly pressed obliquely against the road surface, and as a result, the stress resulting from the incompressibility of rubber is further largely born by the central portion of the block land portion. The force accompanied by this compression and deformation is applied in the same direction as the traveling direction of the vehicle, and is added with the driving force from the engine torque, which leads to increase in the sliding wear. Therefore, by increasing the length of the block land portion in the widthwise cross section of the tire from both end portions 7, 7 of the block land portion 4 in the circumferential direction of the tire toward the central portion 8 of the block land portion 4 as described above, it is possible to concentrate the compressive stress on the central area of the block land portion 4 as shown in FIG. 8(b) when the block land portion 4 is obliquely brought into contact with the road surface. As a result, even if there occurs a force that causes the rubber at the central area of the block land portion 4 to deform in the direction from the trailing edge 11 toward the leading edge 12, forces Q occur in a manner that wall portions of the block land portion 4 located on the trailing edge side of the block land portion 4 and obliquely inclined with respect to the tire circumferential direction expand in the direction normal to said wall portions of the block land portion, as shown in FIG. 7. At this time, components R of the forces Q acting to expand are generated from the right and the left wall portions of the block land portion 4 and act in opposite directions to each other, and most of the components R are cancelled with each other within the block land portion 4, whereby the other components P of the forces Q act against the force that causes the rubber at the central area of the block land portion 4 to deform from the trailing edge 11 toward the leading edge 12. Therefore, the excess deformation of the block land portion 4 is suppressed, whereby it is possible to prevent the partial wear and the sliding wear of the block land portion 4.

Further, as shown in FIG. 9, comparison was made between deformation (solid line) of a block land portion in the case where driving force is applied to the block land portion that does not have the shape described above, and deformation (broken line) of a block land portion in the case where driving force is applied to a block land portion 4 having the above-described shape and arrangement according to the present invention. In the block land portion 4 according to the present invention, although deformation of the rubber toward

the trailing edge side of the block is suppressed at the step-in time due to the same mechanism as that of the kick-out time, the incompressibility of rubber causes the suppressed deformation to act in a direction in which the trailing edge 11 of the block land portion 4 that has been already stepped in is made further rise. This increases the shearing deformation of a block land portion 4 to be stepped in next, thereby producing a synergistic effect as shown in FIG. 4 in which the shearing force at the step-in time increases and the shearing force at the kick-out time decreases, which has larger effect on the wear. Note that, at this time, a ratio of a length A of the block land portion 4 in the tire width direction at an edge portion in the tire circumferential direction with respect to a length B of the block land portion 4 in the tire width direction at the central portion 8 of the block land portion 4 is preferably set in the range of 1:3 to 1:1.5. This is because it is preferable to set the ratio of A to B in the range of 1:3 to 1:1.5, from the viewpoint of effectively suppressing the deformation of the block land portion 4 in such a case where the block land portion 4 is obliquely brought into contact with the road surface, thereby effectively suppressing the partial wear and the sliding wear of the block land portion 4.

Further, it is preferable that, concerning the same block land portion 4, the groove portion 6 between block land portions located adjacent in the tire width direction and facing the same circumferential groove 2 forms an open angle opening to the opposite direction to the tire equatorial plane CL as viewed from the tire circumferential direction. This is because, in the case where the groove portion 6 between the block land portions adjacent in the tire width direction extends in one direction, it is possible to effectively deal with an input from a certain one direction to prevent the sliding wear, but there is a possibility that the groove portion cannot effectively deal with an input from other direction and cannot prevent the sliding wear. Further, the inclination of the extending direction of the groove portion between the block land portions adjacent in the tire width direction is disposed so as to face the inclination of the block land portion 4 resulting from the shape in which the widthwise cross section of the tire at the central portion of the block land portion 4 increases. This makes it possible to pattern the blocks without generating wasted spaces in the tire width direction, while effectively achieving the wear resistance performance without deteriorating any of the configuration and the effects, whereby it becomes easy to implement patter designing by combining with a second rib, shoulder rib, lug and the like.

Further, a ratio of the distance d_1 between the block land portions adjacent in the tire circumferential direction with respect to the distance d_2 between the block land portions adjacent in the tire width direction is preferably in the range of 1:0.85 to 1:0.3, and is more preferably in the range of 1:0.7 to 1:0.4. In the case where the ratio of the distance d_1 between the block land portions adjacent in the tire circumferential direction with respect to the distance d_2 between the block land portions adjacent in the tire width direction exceeds 1:0.3, the distance d_2 between the block land portions adjacent in the tire width direction is undesirably short even if the distance d_1 between the block land portions adjacent in the tire circumferential direction is sufficient. Therefore, the block land portions 4 adjacent in the tire width direction are brought into contact with each other when the tire is rotated with load; the deformation force resulting from collapsing and deforming cannot be effectively transferred to the block land portion 4 adjacent in the tire width direction; and, the shearing force within the block land portion 4 cannot be effectively dispersed, possibly causing the sliding wear. On the other hand, in the case where the ratio of the distance d_1

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between the block land portions adjacent in the tire circumferential direction with respect to the distance d_2 between the block land portions adjacent in the tire width direction is less than 1:0.85, the distance d_1 between the block land portions adjacent in the tire circumferential direction is undesirably short even if the distance d_2 between the block land portions adjacent in the tire width direction is sufficient. Therefore, the block land portions 4 are brought into contact with each other in the tire circumferential direction when the block land portions 4 come into contact with the road surface, and the deformation due to expansion of rubber illustrated in FIG. 5 occurs, possibly reducing the wear resistance.

Yet further, a ratio of the length d_5 of the block land portion 4 in the tire circumferential direction with respect to the distance d_1 between block land portions adjacent in the tire circumferential direction is preferably in the range of 1:0.25 to 1:0.05, and is more preferably in the range of 1:0.17 to 1:0.07. In the case where the ratio of the length d_5 of the block land portion 4 in the tire circumferential direction with respect to the distance d_1 between block land portions adjacent in the tire circumferential direction exceeds 1:0.05, the block land portions 4 adjacent in the tire circumferential direction are undesirably close to each other when the block land portion 4 collapses and deforms at the time of rotation of tire with load. Therefore, as illustrated in FIG. 5, when the block land portions 4 of the tread portion 1 that are in contact with the road surface are pressed and deformed, the block land portions 4 adjacent in the tire circumferential direction are brought into contact with each other at the center of the tread portion 1; another block land portion 4 located outer than said block land portions 4 is pressed toward the outer side in the tire circumferential direction; the block land portions 4 excessively collapse and deform both in a tire rotation direction and in a direction opposite to the tire rotation direction. This increases a force acting at the trailing edge 11 in a direction in which the driving force is applied, possibly causing the sliding wear resulting from said collapsing and deformation. On the other hand, in the case where the length d_5 of the block land portion 4 in the tire circumferential direction with respect to the ratio of the distance d_1 between the block land portions adjacent in the tire circumferential direction is less than 1:0.25, the block land portions 4 adjacent in the tire circumferential direction are undesirably spaced from each other. This makes it impossible to utilize the shearing force at the trailing edge 11 of the block land portion 4 so as to disperse the shearing force at the block land portions 4 adjacent in the tire circumferential direction in a well-balanced manner, also possibly causing the sliding wear.

Yet further, the distance d_2 between the block land portions adjacent in the tire width direction is preferably in the range of 1.0 to 5.0 mm, and is more preferably in the range of 1.5 to 3.5 mm. In the case where the distance d_2 between the block land portions in the tire width direction exceeds 5.0 mm, the distance d_2 between the block land portions adjacent in the tire width direction is undesirably long. Therefore, the deformation force resulting from collapsing and deforming cannot be transferred to the block land portions 4 adjacent in the tire width direction. This causes the block land portion 4 to excessively collapse and deform in the tire circumferential direction, possibly causing the wear resulting from the sliding of the block land portion 4. On the other hand, the distance d_2 between the block land portions adjacent in the tire width direction is less than 1.0 mm, the distance d_2 between the block land portions adjacent in the tire width direction is undesirably short. Therefore, the block land portions 4 adjacent in the tire width direction are brought into contact with each other when the tire is rotated with load, and the deformation force resulting from the collapsing and deforming cannot be effectively transferred to the block land portion 4 adjacent in the tire width direction. This causes the block land portion 4 to excessively collapse and deform, also possibly causing the wear resulting from the sliding of the block land portion 4.

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Yet further, the distance d_1 between the block land portions adjacent in the tire circumferential direction is preferably in the range of 3.0 to 10.0 mm, and is more preferably in the range of 4.0 to 8.0 mm. In the case where the distance d_1 between the block land portions adjacent in the tire circumferential direction exceeds 10.0 mm, the distance d_1 between the block land portions adjacent in the tire circumferential direction is undesirably long. This excessively increases the road-contacting pressure at the block land portion 4, possibly reducing the wear resistance. On the other hand, in the case where the distance d_1 between the block land portions adjacent in the tire circumferential direction is less than 3.0 mm, the distance d_1 between the block land portions adjacent in the tire circumferential direction is undesirably short. This causes the block land portions 4 to be brought into contact with each other in the tire circumferential direction at the time of coming into contact with the road surface, and deformation occurs due to expansion of rubber as illustrated in FIG. 5, possibly reducing the wear resistance.

Yet further, as illustrated in FIGS. 10 and 11, it is preferable that the block land portion 4 is provided with a narrow groove 13 communicating, in the tire width direction, the two circumferential grooves 2, 2 adjacent to said block land portion 4. By providing an additional trailing edge 11 as described above, it is possible to generally improve the gripping force at the block land portion 4. Therefore, it is possible to efficiently convert the torque from the engine into the driving force. Note that, at this time, the narrow groove 13 may be curved or bent within the block land portion 4.

Yet further, it is preferable for the narrow groove 13 to open to the circumferential groove 2 at the central portion 8 of the block land portion 4. This is because, if the narrow groove 13 opens at a region other than the central portion 8 of the block land portion 4, the gripping force serving as the driving force cannot be dispersed in a well-balanced manner within the block land portion 4, and hence, there is a possibility that the torque from the engine cannot be efficiently converted into the driving force.

Yet further, it is preferable for the length of the narrow groove 13 in the tire circumferential direction to be in the range of 5 to 20% of a depth of the lateral groove 3 (depth in a radial direction), and more preferably be in the range of 7 to 18%. In the case where the length of the narrow groove 13 in the tire circumferential direction is less than 5% of the depth of the lateral groove 3, the length of the narrow groove 13 in the tire circumferential direction is undesirably short. As a result, similar to the case where the block land portion 4 is not provided with the narrow groove 13, the gripping force decreases from the leading edge 12 toward the trailing edge 11, and hence, there is a possibility that the effect obtained by disposing the narrow groove 13 does not work. On the other hand, in the case where the length of the narrow groove 13 in the tire circumferential direction exceeds 20% of the depth of the lateral groove 3, the length of the narrow groove 13 in the tire circumferential direction is undesirably long. As a result, the force resulting from the reaction between the block land portions 4, each of which is separated by the narrow groove 13 in the block land portion 4, cannot be transferred, causing the block land portion to excessively collapse and deform, and possibly causing the sliding wear resulting from this. Further, in order to maintain the sufficient effect until the end of the

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wear, it is preferable for the depth of the narrow groove 13 to be in the range of 60 to 100% of the depth of the lateral groove 3.

Further, it is preferable for the length d_3 of the block land portion 4 in the tire circumferential direction to be in the range of 1.0 to 2.5% of a circumferential length of the tire. In order to effectively obtain the above-described effect of the block land portion 4 according to the present invention, it is appropriate that the length d_3 of the block land portion 4 in the tire circumferential direction is less than or equal to 2.5% of a circumferential length of the tire. This is because, in the case where said value exceeds 2.5%, the rigidity against shearing force of the block excessively increases, and hence there is a possibility that the block land portion 4 that has already been stepped in does not sufficiently rise in a manner described above. On the other hand, in the case where the length d_3 of the block land portion 4 in the tire circumferential direction is less than or equal to 2.5% of the circumferential length of the tire but the length d_3 is less than 1.0%, the rigidity of the block land portion 4 is undesirably low. Thus, in such a case, when the driving force is applied to the block land portion 4, the block land portion 4 excessively shears and deforms, and hence, the sliding wear cannot be sufficiently suppressed. Accordingly, by setting the length d_3 of the block land portion 4 in the tire circumferential direction to be in the range of 1.0 to 2.5% of the circumferential length of the tire, it is possible to secure the rigidity of the block land portion 4, and the effect of the block land portion 4 described above can be achieved effectively, whereby there is a possibility that the wear resistance can be prevented from deteriorating.

It should be noted that the description above is only a part of the embodiment of the present invention, and it may be possible to alternately combine these configurations or apply various modifications without departing from the gist of the present invention. For example, in tires having the configurations illustrated in FIGS. 2, 6, 10 and 11, two block land portion arrays 5 form one unit, and plural units are arranged on the road-contacting surface of the tread portion to obtain the effect according to the present invention. However, it may be possible to arrange only single unit, or to form single unit by three or more block land portion arrays 5 and arrange them on the surface of the tread portion. Alternatively, various tread patterns are possible, provided that the tread portion has the configurations according to the present invention. More specifically, as illustrated in FIG. 12, rib-like land portions 14 may be provided on the shoulder sides of the tread portion 1, and, the above-described configurations of the present invention may be employed for block land portion arrays 5 between the rib-like land portions 14; or, as illustrated in FIG. 13, block land portion arrays 5 formed by rectangular-shaped land portions 4 may be provided on the shoulder sides of the tread portion 1, and the above-described configurations of the present invention may be employed for block land portion arrays 5 between the rectangular-shaped block land portion arrays 5; or, as illustrated in FIG. 14, block land portion arrays 5A formed by rectangular-shaped block land portions 4 and block land portion arrays 5B formed by hexagonal-shaped block land portions 4 may be provided on the shoulder sides of the tread portion 1, and the above-described configurations of the present invention may be employed for block land portion arrays 5 located between the block land portion arrays 5A and 5B and disposed on the tire equatorial plane CL side. Alternatively, as illustrated in FIG. 15, in adjacent block land portion arrays 5 located on the tire equatorial plane CL side and having the configuration according to the present invention, two side walls facing a circumferential groove 2A may have the same projected length, each of which projected

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lengths is a length obtained by projecting the side walls to a line parallel to the tire circumferential direction. Alternatively, although not illustrated, in the block land portion array 5 having the configuration according to the present invention, it may be possible to form the side wall facing the circumferential groove 2A not by two faces, but by single face. Alternatively, from the viewpoint of improving the partial wear resistance while maintaining the effect obtained by the present invention, it may be possible to form a corner portion of the block land portion 4 in the block land portion array 5 having the configuration according to the present invention in a chamfered shape, as illustrated in FIG. 15. Further, although not illustrated, it is possible to form the side walls 9, 10 of the block land portion 4 in a curved shape so as to have a curvature while maintaining the effect obtained by the present invention. At this time, the projected lengths obtained by projecting the side walls 9, 10 to a line parallel to the tire circumferential direction are measured on the basis of the end portions of the side walls 9, 10 of the block land portion 4 in the circumferential direction and the intersecting point connecting two faces of the side walls 9, 10 with a straight line or curved line.

EXAMPLE

Next, as samples of pneumatic tires for heavy load having a size of 495/45R22.5, there were prepared a pneumatic tire (Conventional Example tire) having a tread pattern according to the conventional technique, pneumatic tires (Comparative Example tires 1 to 9) each having a configuration similar to the pneumatic tire according to the present invention, and a pneumatic tire (Example tire) according to the present invention, and performance evaluation was made for those tires. Details of the evaluation will be described below.

The Conventional Example tire has block land portions having a rectangular shape as illustrated in FIG. 16, and has characteristics shown in Table 1. The Comparative Example tires 1 to 9 have configurations illustrated in FIG. 17 through FIG. 25, respectively, and have characteristics shown in Table 1. The Example tire has a tread portion corresponding to that illustrated in FIG. 26, and is a pneumatic tire having block land portions arranged on the entire tread portion thereof. Further, between block land portion arrays adjacent to each other, the block land portions constituting the block land portion arrays are arranged so as to be positionally displaced by a half pitch from each other in the tire circumferential direction. Yet further, a groove portion 6 between the block land portions adjacent in the tire width direction extends obliquely with respect to the tire circumferential direction; a distance between block land portions adjacent in the tire width direction is shorter than a distance between block land portions adjacent in the tire circumferential direction. Still yet further, the length of the block land portion in the widthwise cross section of the tire increases from both end portions of the block land portion in the tire circumferential direction toward the central portion of the block land portion. Still yet further, in the block land portions in the block land portion arrays adjacent in the tire width direction, two side walls facing the groove portion located between the block land portions adjacent in the tire width direction have the projected lengths d_3 and d_4 different from each other, each of which projected lengths is a length obtained by projecting the side walls to a line parallel to the tire circumferential direction, and characteristics thereof are shown in Table 1.

TABLE

	Conventional Example tire	Comparative Example tire 1	Comparative Example tire 2	Comparative Example tire 3	Comparative Example tire 4	Comparative Example tire 5
Corresponding drawing	FIG. 16	FIG. 17	FIG. 18	FIG. 19	FIG. 20	FIG. 21
Length of block land portion in tire circumferential direction	60.0 mm	60.0 mm	60.0 mm	60.0 mm	60.0 mm	60.0 mm
Length in tire width direction of end portion of block land portion in the tire circumferential direction	40.0 mm	19.0 mm	27.0 mm	27.0 mm	27.0 mm	16.0 mm
Length in tire width direction of central portion of block land portion	40.0 mm	38.0 mm	27.0 mm	20.0 mm	33.0 mm	38.0 mm
Depth of lateral groove	18.0 mm	18.0 mm	18.0 mm	18.0 mm	18.0 mm	18.0 mm
Distance between block land portions adjacent in tire width direction	10.0 mm	10.0 mm	3.0 mm	3.0 mm	3.0 mm	3.0 mm
Depth of groove portion between block land portions adjacent in tire width direction	15.0 mm	15.0 mm	15.0 mm	15.0 mm	15.0 mm	15.0 mm
Distance between block land portions adjacent in tire circumferential direction	7.0 mm	7.0 mm	7.0 mm	7.0 mm	7.0 mm	7.0 mm
Inclined angle of side walls of block land portion with respect to tire circumferential direction	0°/0°	20°/-20°	20°/20°	20°/-20° 0°/0°	20°/-20° 0°/0°	20°/-20°
Projected length of side walls of block land portion (d3/d4)	30 mm/30 mm	30 mm/30 mm	30 mm/30 mm	30 mm/30 mm	30 mm/30 mm	30 mm/30 mm
Presence/absence of narrow groove	Not exist	Not exist	Not exist	Not exist	Not exist	Not exist
Width of narrow groove	—	—	—	—	—	—
Depth of narrow groove	—	—	—	—	—	—
Presence/absence of bent of narrow groove	—	—	—	—	—	—
Number of block land portion arrays adjacent in tire width direction	—	—	2	2	2	2
	Comparative Example tire 6	Comparative Example tire 7	Comparative Example tire 8	Comparative Example tire 9	Example tire	
Corresponding drawing	FIG. 22	FIG. 23	FIG. 24	FIG. 25	FIG. 26	
Length of block land portion in tire circumferential direction	60.0 mm	60.0 mm	60.0 mm	60.0 mm	60.0 mm	
Length in tire width direction of end portion of block land portion in the tire circumferential direction	18.0 mm	16.0 mm	16.0 mm	30.0 mm	16.0 mm/16.0 mm	
Length in tire width direction of central portion of block land portion	40.0 mm	38.0 mm	38.0 mm	61.0 mm	38.0 mm	
Depth of lateral groove	18.0 mm	18.0 mm	18.0 mm	18.0 mm	18.0 mm	
Distance between block land portions adjacent in tire width direction	0.8 mm	3.0 mm	3.0 mm	1.8 mm	3.0 mm	
Depth of groove portion between block land portions adjacent in tire width direction	15.0 mm	15.0 mm	15.0 mm	15.0 mm	15.0 mm	
Distance between block land portions adjacent in tire circumferential direction	7.0 mm	7.0 mm	7.0 mm	4.0 mm	7.0 mm	
Inclined angle of side walls of block land portion with respect to tire circumferential direction	20°/-20°	20°/-20°	20°/-20°	27°/-27°	36°/14°	
Projected length of side walls of block land portion (d3/d4)	30 mm/30 mm	30 mm/30 mm	30 mm/30 mm	30 mm/30 mm	15.0 mm/45.0 mm	
Presence/absence of narrow groove	Not exist	Exist	Exist	Exist	Not exist	

TABLE-continued

Width of narrow groove	—	1.0 mm	1.0 mm	1.0 mm	—
Depth of narrow groove	—	15.0 mm	15.0 mm	15.0 mm	—
Presence/absence of bent of narrow groove	—	Not exist	Exist	Exist	—
Number of block land portion arrays adjacent in tire width direction	2	2	2	5	2

Each of the sample tires described above was assembled with a rim having a size of 17.00×22.5 to form tire wheels, and were inflated at a pressure of 900 kPa (relative pressure), and various evaluations as described below were made.

For the wear resistance property, the above-described tire wheels were mounted to a tractor vehicle for use in tests as a driving wheel, and load mass of 57 kN is applied to the tires. Then, the amount of wear at the central portion of the block land portion was measured after traveling 50000 km on a test road. With the amount of wear of the central portion of the block land portion of the Conventional Example tire being set to 100 as index, relative values were obtained for the other tires, and the evaluation was made by comparing the thus obtained relative values. Note that the smaller value represents the better wear resistance. Table 2 shows the results thereof.

For the quietness property, the above-described tire wheels were mounted to a drum test device, and load mass of 57 kN is applied to the tires.

Then, the sound at the side of the tires when traveling on an in-room drum test device was measured at a speed of 80 km/h under the condition specified in JASO C606, and partial overall values were calculated for a 1/3-octave band level with the center frequency of 800-1000-1250 Hz. With the sound of the Comparative Example tire 5 being set to 100 as index, relative values were obtained for the Example tire, and the evaluation was made by comparing the thus obtained relative values. Note that the smaller value represents the better quietness property. Table 2 shows the results thereof

TABLE 2

	Corresponding drawing	Wear resistance	Quietness
Conventional Example tire	FIG. 16	100	—
Comparative Example tire 1	FIG. 17	93	—
Comparative Example tire 2	FIG. 18	83	—
Comparative Example tire 3	FIG. 19	83	—
Comparative Example tire 4	FIG. 20	79	—
Comparative Example tire 5	FIG. 21	76	100
Comparative Example tire 6	FIG. 22	86	—
Comparative Example tire 7	FIG. 23	71	—
Comparative Example tire 8	FIG. 24	74	—
Comparative Example tire 9	FIG. 25	67	—
Example tire	FIG. 26	77	94

As can be clearly understood from the results shown in Table 2, the Example tire and the Comparative Example tires 1 to 9 exhibit improved wear resistance as compared with the Conventional Example tire. Further, as a result of comparison of the Example tire with the Comparative Example tire 5 having the configuration same as the Example tire except that the configuration of the side walls of the block land portion falls outside the range of the present invention, it can be known that both of the tires exhibit the same wear resistance. In terms of the quietness property, the Example tire improves as compared with the Conventional Example tire 5.

INDUSTRIAL APPLICABILITY

As can be clearly understood from the description above, according to the present invention, it is possible to provide a tire exhibiting both improved wear resistance and improved quietness, by optimizing the shapes of the block land portions and positional arrangement thereof.

EXPLANATION OF REFERENCE CHARACTERS

- 1 Tread portion
- 2, 2A Circumferential groove
- 3 Lateral groove
- 4 Block land portion
- 5, 5A, 5B Block land portion array
- 6 Groove portion between block land portions adjacent in the tire width direction
- 7 End portion of block land portion in the tire circumferential direction
- 8 Central portion of block land portion
- 9, 10 Side wall of block land portion
- 11 Trailing edge
- 12 Leading edge
- 13 Narrow groove
- 14 Rib-like land portion

The invention claimed is:

1. A tire having, on a tread portion, a plurality of circumferential grooves extending in a tire circumferential direction, and plural lateral grooves each communicating adjacent two circumferential grooves, thereby defining a plurality of block land portion arrays formed by a large number of block land portions, wherein:

between block land portion arrays located adjacent to each other while sandwiching the circumferential groove, the block land portions constituting said block land portion arrays are arranged so as to be positionally displaced from each other in the tire circumferential direction;

a groove portion between the block land portions adjacent in the tire width direction extends obliquely with respect to the tire width direction and the tire circumferential direction;

a distance between the block land portions adjacent in the tire width direction is shorter than a distance between the block land portions adjacent in the tire circumferential direction;

in the adjacent block land portion arrays, the block land portion is adjacent to at least two block land portions by way of a groove portion between block land portions adjacent in the tire width direction;

two side walls of the adjacent block land portion have projected lengths different from each other, the projected lengths being obtained by projecting the side walls to a line parallel to the tire circumferential direction; and,

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the block land portions adjacent in the tire width direction are disposed in a point-symmetric manner by way of the groove portion between the block land portions adjacent in the tire width direction,

wherein a length of the block land portion in a widthwise cross section of the tire continuously increases from both end portions of the block land portion in the tire circumferential direction toward a central portion of the block land portion. 5

2. The tire according to claim 1, wherein of the two side walls having the projected lengths different from each other, a projected length of one side wall has a length in the range of 1.2 to 6.0 times a projected length of the other side wall. 10

3. The tire according to claim 1, wherein the lateral groove extends obliquely with respect to the tire width direction. 15

4. The tire according to claim 1, wherein the lateral groove extends obliquely with respect to the tire width direction at an angle in the range of 5 to 45°. 20

5. The tire according to claim 1, wherein a distance between the block land portions adjacent in the tire circumferential direction with respect to a distance between the block land portions adjacent in the tire width direction is in the range of 1:0.85 to 1:0.3.

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6. The tire according to claim 1, wherein a length of the block land portion in the tire circumferential direction with respect to a distance between the block land portions adjacent in the tire circumferential direction is in the range of 1:0.25 to 1:0.05.

7. The tire according to claim 1, wherein a distance between the block land portions adjacent in the tire width direction is in the range of 1.0 to 5.0 mm.

8. The tire according to claim 1, wherein a distance between the block land portions adjacent in the tire circumferential direction is in the range of 3.0 to 10.0 mm.

9. The tire according to claim 1, wherein the block land portion is provided with a narrow groove communicating, in the tire width direction, two circumferential grooves adjacent to said block land portion.

10. The tire according to claim 9, wherein the narrow groove is open to the circumferential groove at the central portion of the block land portion.

11. The tire according to claim 9, wherein the length of the narrow groove in the tire circumferential direction is in the range of 5 to 20% of a depth of the lateral groove.

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